



**INSTITUT
POLYTECHNIQUE
DE PARIS**

Mechanics Seminar series 2024 – 25

How freezing breaks soft, wet materials

Speaker: Robert Style, ETH Zurich

Date: July 3, 2025 (2 - 3 pm)

Venue: Amphi 104 (pole meca)

Abstract

It is widely known that freezing breaks soft, wet materials. However, the mechanism underlying this damage is still not clear. To understand this process, we freeze model, brittle hydrogel samples, while observing the growth of ice-filled cracks that break these apart. I will explain how damage is not caused by the expansion of water upon freezing, or the growth of ice-filled cavities in the hydrogel. Instead, local ice growth dehydrates the surrounding hydrogel, leading to drying-induced fracture. This dehydration is driven by the process of cryosuction, whereby undercooled ice sucks nearby water towards itself, feeding its growth. The results highlight a strong analogy between freezing damage and desiccation cracking. As a follow up, I will also show how freezing hydrogels is a powerful technique for measuring their elastic and transport material properties (e.g. hydraulic permeability).

About the speaker

Robert Style obtained his PhD from the University of Cambridge studying the physics of sea ice. He then moved to Oxford and Yale as a postdoctoral researcher working on frost heaving and elastocapillarity. From 2014 to 2016, he became Departmental Lecturer at Oxford and subsequently moved to ETH Zurich as a group leader in 2016. His work spans several areas of Soft Matter at the interface between fluid and solid mechanics such as Phase separation, Fracture, Capillary effects, Friction, and Freezing.